

II. "An Account of the two Methods of Reproduction in *Daphnia*, and of the Structure of the 'Ephippium.'" By JOHN LUBBOCK, Esq., F.G.S. Communicated by CHARLES DARWIN, Esq., F.R.S. Received December 22, 1856.

(Abstract.)

In this paper the author describes the male organs and the structure of the Ephippium in the genus *Daphnia*, and the double method of reproduction by agamic and ephippial eggs. The author calls the non-ephippial eggs agamic, but it is possible, though not probable, that the ephippial eggs may be agamic also. In the male *Daphnia* there are two small papillæ above the posterior claws, but on the ventral side of the anus, and on these being compressed, two streams of minute rod-like bodies, with movements so gentle as to be scarcely visible, will be seen to issue, one from each papilla. Nothing similar has ever been observed in the female; nor has any other sort of spermatozoa ever been met with. These male organs have never been described before.

The author then proceeds to describe and figure the two sorts of eggs in their earlier stages, which have not yet been mentioned by any naturalist. The ephippial eggs differ from the agamic in their determinate position and number. As a general rule, that is to say, in seventeen cases out of twenty-three, the author has remarked that ephippial eggs commence and are developed to a certain point.

The development is as follows. One of the ovarian cells, always at the posterior part of the ovary, swells a little, and becomes a germinative vesicle; round it are deposited a number of brownish granules, while the other cells which may at first have existed in the same ovarian mass cease to be visible. The deposition of dark granules, in thirty-seven cases out of forty, after proceeding to a certain point, ceased, and the embryo egg gradually disappeared. In the other three cases it increased, and at length formed a dark mass on each side of the intestinal canal. The author in two cases observed the ephippial eggs pass from the ovary into the receptacle.

The ephippium has been described by Strauss with considerable accuracy, but he has been more or less misunderstood by all subsequent writers on the subject, and no one has explained the homologies or connexions of the inner valve. The ephippium itself is

a locally altered portion of the carapace ; the outer valve of the ephippium being a part of the outer layer of the epidermis, and the inner valve the corresponding part of the inner layer. In consequence of this arrangement, the inner valve of the ephippium, containing the ephippial eggs, is not attached by the hinge to the outer valve, as has been generally stated, but actually lies at first in the receptacle formed by the new carapace. The ephippium is cast with the rest of the skin, from which however it soon becomes detached, and continues to form an efficient protection to the eggs until they are hatched. These eggs probably require to be fertilized, but this fact is not completely proved. With one exception, whenever the author observed ephippia, he could also find males ; and, generally speaking, the numbers of each were in proportion to one another. Impregnation is not, however, absolutely necessary to the production of ephippia, as the author has now in his possession three ephippia, formed by isolated females. It remains to be seen whether young will be developed from these or not.

The early stages of the agamic egg are very similar to those of the ephippial egg, and consist of the enlargement, in the front part of the ovary, of one of the ovarian cells, which then becomes a germinal vesicle, and the deposition round it of granules, with the addition in this case of oil-globules. This process continues, the other two or three cells which may have existed in the same ovarian mass gradually disappear, and there is thus formed an egg-like mass, consisting of a germinal vesicle, minute dark granules, and large oil-globules. When the growth is nearly completed, the vitelline membrane is added. This is at first very delicate, but after deposition in the receptacle soon becomes hard. The ovarian eggs of *Daphnia*, as well as those of *Cypris*, never contain round masses like those of *Aphis* and *Musca* ; but after their entry into the receptacle, yolk masses are found, homologous with those present at the corresponding periods in *Phryganea*\*. The eggs when laid are about  $\frac{2}{200}$  of an inch in diameter ; they gradually become  $\frac{2}{200}$ , when the vitelline membrane splits and falls off, and the young animal is hatched. Far, however, from resembling its parent at this time, the young *Daphnia*

\* The round balls described by Herold in the ovarian eggs of *Bombyx*, appear to be of a different nature, and homologous with the Nahrungsdotter mentioned by Carus in spiders' eggs and the oil-globules of *Daphnia*.

is a spherical bag, inside which the formation and development of the new organs is rapidly progressing\*. Instead therefore of undergoing no metamorphosis, the young Daphnia only assumes the well-known characters of the genus after the first changes of skin. The author proceeds to compare this phenomenon with a similar one observed by Mr. Spence Bate in *Gammarus*, by Prof. Huxley in *Mysis*, by Dr. Cohn in *Sphæropœla*, in many Annelids, and in the interesting entozoon *Monostomum mutabile*. The young Daphnia attains a length of .025 inch before it leaves the receptacle of the mother, but the length of time during which it remains therein varies according to the temperature. The author has never met with an exception to the rule noticed by preceding writers, that unisexuality is characteristic of an agamic brood.

It follows from these observations, that the self-fertile Daphniæ are certainly true females, and that the reproductive bodies more nearly resemble eggs than gemmæ in their origin and development. Hereafter, however, it may be convenient to give a separate name to those egg-like bodies, which are fertile without impregnation, but for the present they must be called eggs.

The author then gives a list of the instances of Parthenogenesis which, so far as he knows, are recorded among the Articulata. Finally, he expresses the belief that the careful consideration of these cases, and of the facts now recorded as to *Daphnia*, and the still more wonderful observations recently detailed by Siebold in regard to *Apis* (if these latter are confirmed), must surely remove all lingering doubts as to the identity between eggs and buds; and remarks, that if Prof. Huxley's definition of "individual" and "zoid" is to be adopted, it will be impossible to assert of any Daphnia or Moth, whether it is the one or the other, and the hive-bee will have to be considered as an hermaphrodite, a species without male individuals.

Under these circumstances, the author suggests that it would be more convenient to continue, as heretofore, to call the individual of any species that which is individualized, even though in this case the individuals of one species will not always be homologous with those of another.

\* It is worthy of notice, that the back fold indicating the divisions between the head and body is opposite the line between the mandibles and the first pair of maxillæ, which latter appear therefore to belong to the body, as Zaddach also asserts, and not to the head.